RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)					DATE February 2004		
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development			R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, R-1 #44				
COST (In Millions)	FY 2003	FY2004	FY2005	FY 2006	FY 2007	FY 2008	FY 2009
Total Program Element (PE) Cost	216.052	336.658	337.117	324.825	339.748	330.721	336.915
Guidance Technology SGT-01	40.513	43.643	41.452	42.291	50.386	30.999	30.959
Aerospace Surveillance Technology SGT-02	33.850	24.614	36.375	38.289	43.279	32.749	30.720
Air Defense Initiative SGT-03	18.413	31.434	32.861	27.398	29.314	34.167	34.133
Sensors and Exploitation Systems SGT-04	123.276	127.483	130.637	120.867	117.545	128.610	158.463
Classified SGT-CLS	0.000	109.484	95.792	95.980	99.224	104.196	82.640

(U) Mission Description:

(U) The Sensors and Guidance Technology program element is budgeted in the Advanced Technology Development Budget Activity because it is developing the system oriented technologies necessary to enhance sensor and weapon system accuracy and capability to meet current and emerging threats. Four projects are funded in this program element: Guidance Technology, Aerospace Surveillance Technology, the Air Defense Initiative, and Sensors and Exploitation Systems.

(U) The Guidance Technology project will increase the ability of Global Positioning System (GPS) users to operate effectively in presence of enemy jamming; to increase the versatility of navigation systems applications by developing microelectromechanical sensor inertial navigation system technologies; and to apply the geolocation technologies/techniques to precision threat geolocation of short-dwell emitters or passive air defense systems. Fire-and-forget standoff weapons need precise targeting information if critical fixed and mobile targets are to be eliminated effectively with minimal collateral damage and minimum cost-per-kill. This requires that: (1) military surveillance and targeting systems geolocate targets accurately in the same coordinate system in which the weapon system navigates; (2) the surveillance, targeting and weapon systems have precision navigation and guidance systems on-board; and (3) navigation and target location systems robustly operate day/night and in adverse weather. In addition, future systems designed to accomplish precision strike missions must be significantly more affordable. The achievement of these characteristics in an integrated system is the goal of this program.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, R-1 #44

(U) The Aerospace Surveillance Technology project funds sensor efforts that will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability and battle damage assessment. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with the tactical information needed to succeed in future wars. This operational surveillance capability must continue to perform during enemy efforts to deny and deceive the sensor systems, and operate, at times, in a covert manner. This project will exploit recent advances in multispectral target phenomenology, signal processing, low-power high-performance computing, and low-cost microelectronics to develop advanced surveillance and targeting systems. Surveillance is not an end to itself, but rather an enabler for force protection and precision strike. Therefore, a key component of this program is the development of a comprehensive sensor-to-shooter architecture.

(U) The Air Defense Initiative project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats. These technology developments are embodied in programs such as the Low-Cost Cruise Missile Defense (LCCMD), Global Eye, Affordable Large Array (ALA), RF MEMS Improvement, and the Integrated Sensor Is Structure (ISIS) programs.

(U) The Sensors and Exploitation Systems project funds development and demonstration of advanced sensors. Tools that extract and compile information from data provided by sensors are elements of the project. These efforts, along with those in Projects SGT-01, SGT-02 and SGT-03, provide warriors with situational awareness and precision target identification. The project is driven by four needs: (1) countering camouflage, concealment and deception (CC&D); (2) providing near-real-time, semi-automatic exploitation of wide-area moderate- and high- resolution imagery; (3) obtaining real-time, accurate Battle Damage Assessment (BDA); and (4) accomplishing robust, precise identification, precision fire control tracking and engagement of high value targets. These needs are addressed by the following programs: Advanced Exploitation Systems Technology, Network Centric Sensing and Engagement, Advanced Optical Sensor Technology, and Advanced Radar Sensor Technology.

(U) **Program Change Summary:** *(In Millions)*	**FY 2003**	**FY 2004**	**FY2005**
Previous President's Budget	217.378	342.914	354.877
Current President's Budget	216.052	336.658	337.117
Total Adjustments	-1.326	-6.256	-17.760

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, R-1 #44

	FY 2003	FY 2004
Congressional program reductions	0.000	-6.256
Congressional increases	0.000	0.000
Reprogrammings	1.611	0.000
SBIR/STTR transfer	-0.285	0.000

(U) Change Summary Explanation:

FY 2003	Decrease reflects minor reprogramming with an offset for the SBIR transfer.
FY 2004	Decrease reflects congressional undistributed reductions.
FY 2005	Decrease reflects a reduction in classified programs and minor repricing of other programs.

THIS PAGE INTENTIONALLY LEFT BLANK

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-01

COST (In Millions)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Guidance Technology SGT-01	40.513	43.643	41.452	42.291	50.386	30.999	30.959

(U) **Mission Description:**

(U) Fire-and-forget standoff weapons need precise targeting information if critical fixed and mobile targets are to be eliminated effectively with minimal collateral damage and minimum cost-per-kill. This requires that: (1) military surveillance and targeting systems geolocate targets accurately in the same coordinate system in which the weapon system navigates; (2) the surveillance, targeting and weapon systems have precision navigation and guidance systems on-board; and (3) navigation and target location systems robustly operate day/night and in adverse weather. In addition, future systems designed to accomplish precision strike missions must be significantly more affordable. Thrusts are included in this project to improve our ability to navigate when GPS is jammed or otherwise unavailable; to increase the versatility of navigation systems applications by developing microelectromechanical sensor inertial navigation system technologies; to apply the geolocation technologies/techniques to precision threat geolocation of short-dwell emitters or passive air defense systems; and to develop passive tagging capabilities.

(U) **Program Accomplishments/Planned Programs:**

	FY 2003	FY 2004	FY 2005
Global Positioning Experiments (GPX)	9.134	4.000	0.000

(U) The Global Positioning Experiments (GPX) program increases the ability of GPS users to operate effectively in the presence of enemy jamming or countermeasures by demonstrating the feasibility of airborne pseudolite (APL) concepts. By receiving and re-transmitting GPS signals at substantially higher power levels, the APL overcomes the effects of jamming on DoD receivers and enable continuous operation. APLs can be rapidly deployed on unmanned aerial vehicles (or other airborne platforms) and provide theater-wide coverage for individual soldiers, combat platforms and precision GPS-guided shoot-to-coordinate weapons. The program addressed three key challenges. First, it demonstrated non-Keplerian orbit predictions of the APL and showed that only software modifications are needed for GPS user receivers. Second, it showed that the APL can accurately navigate using GPS satellites in the presence of jamming. A demonstration was conducted of a digital adaptive

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-01

beamformer integrated with a pseudolite in a GPS jamming environment in both a full scale anechoic chamber and full scale field test, with greater than 45 dB nulls against up to six different jammers. Third, the program minimized the impact of APL technology on friendly, unmodified receivers and maximized interoperability through development of advanced waveforms, demonstration of an advanced beam shaping transmit antenna, precise management of the radiated power, and the associated command and control structure. The GPX program culminates with integrated demonstrations of APL or specialized signals capability in military exercises. In addition, APL methods have been investigated for exploitation of signals from satellites of opportunity for precision localization in the absence of GPS.

(U) Program Plans:
- Fabricated and integrated multiple airborne pseudolites.
- Conducted airborne testing campaign; demonstrated successful navigation and interoperability in GPS jamming environment using multiple airborne pseudolites.
- Demonstrated shaped transmit beam solution to near-far issue.

	FY 2003	FY 2004	FY 2005
Advanced Tactical Targeting Technology (AT3)	11.023	5.815	0.000

(U) The Advanced Tactical Targeting Technology (AT3) program is demonstrating a passive tactical targeting system against short-dwell emitters to improve lethal suppression of enemy air defenses (SEAD). The targeting system will negate emitter shutdown tactics now employed to defeat anti-radiation missiles (ARM) guidance, and thereby enable simplified ordnance inventories. The goal is generation and distribution of near real-time, comprehensive, and highly precise location of threat radars to all theater combatant aircraft without deploying any additional SEAD-dedicated, emitter-collecting platforms. AT3 will accomplish this by widely deploying emitter collection packages hosted on existing airborne platforms, including combat aircraft. AT3 will integrate distributed multi-platform emitter collections in real-time using existing or planned tactical data links with advanced network management and signal processing. To achieve wide deployment, AT3 focuses on transition through inexpensive-upgrades to digital radar warning receivers. Enabling technologies include: coupled GPS Inertial Measurement Unit (IMU) packages, tactical communications, advanced highly dynamic data fusion network management capabilities, and algorithms to ensure robust, flexible performance of geolocation algorithms for locating multiple emitter types in noisy, high pulse density environments. AT3 has successfully completed strenuous flight tests and real-time multi-ship demonstrations with brassboard hardware.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-01

(U) Program Plans:
- Complete and analyze results from real-time flight tests at western test ranges to ensure that program goals were met.
- Demonstrate AT3 technologies and capabilities.
- Support transition to Air Force and Navy.

	FY 2003	FY 2004	FY 2005
MEDUSA	18.363	26.612	23.952

(U) The Multifunction Electro-Optics for Defense of U.S. Aircraft (MEDUSA) program will develop the technologies and systems to give the U.S. air dominance at low altitude and at night. This program will develop the technologies to leap-frog reactive end-game countermeasures and enable increased threat warning times, denial of launch, and put EO-IR air defense threats at risk. MEDUSA is a three-part technology program: (1) conduct phenomenological measurements and develop countermeasures and target classification/identification techniques; (2) develop critical component technologies such as high power IR laser sources, advanced IR detectors, and fibers for high power IR transmission; and (3) develop and demonstrate an end-to-end MEDUSA system.

(U) Program Plans:
- Develop and evaluate MEDUSA countermeasure and classification techniques and conduct phenomenological measurements.
- Fabricate and evaluate critical component technologies.
- Develop MEDUSA system designs.
- Build and field test a MEDUSA breadboard design against realistic targets and environments.

	FY 2003	FY 2004	FY 2005
Advanced Gyroscopes	0.000	5.216	5.500

(U) The Advanced Gyroscopes program will develop very high-accuracy gyroscopes for extremely precise navigation, with a goal of reducing gyroscopes noise error to 10^{-5} degree/hour or less. This technological leap will enable more robust operations of several magnitudes – from

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-01

underwater (including covert submarine operation and littoral navigation around obstacles) to outer space (from space flight to precise, autonomous satellite positioning). Technical challenges include the exploitation of quantum effects, such as correlated photons and atom interference effects.

(U) Program Plans:
- Evaluate feasibility of underlying approach in the laboratory.
- Develop breadboard gyroscopes and test for ultra-low noise and angle random walk.

	FY 2003	FY 2004	FY 2005
Precision Inertial Navigation Systems	1.993	2.000	7.000

(U) The Microelectromechanical Sensor Inertial Navigation System (MEMS INS) program is improving the silicon based, inertial sensors (gyros and accelerometers) developed in the MEMS technology program and integrate them with navigation software into a low power, small, lightweight, low cost, tactical grade (1.0 degree per hour to 10 degrees per hour drift rate) INS. In addition to handheld applications, the MEMS INS will be generic for insertion/embeddin g into other military systems.

(U) The Precision Inertial Navigation Systems program will develop an entirely new class of inertial navigation instruments using atomic inertial force sensors. These sensors utilize the quantum-mechanical wave-like nature of atoms in the atomic analogue of an optical interferometer to provide unprecedented sensitivity to accelerations and rotations. The atomic sensors will further be used to measure the local gravitational field gradient to ensure that instrument alignment is properly maintained throughout vehicle maneuver, thus mitigating gravity-induced navigation errors. Initial program efforts will focus on developing fundamental technology components upon which later systems would be constructed.

(U) Program Plans:
- Delivered MEMS inertial measurement unit to the DoD.
- Completed field demonstration of MEMS INS navigation capabilities.
- Investigated novel INS designs for very large structures that exploit large baseline separation.
- Investigated MEMS and meso suitability to space applications.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-01

- Develop and demonstrate inertial navigation system with positional bias drift rate below 5 meters/hour.
- Development of integrated "atom-chips" using Bose-Einstein Condensate-based coherent atom sources, including integrated waveguides, vacuum systems, and atom detectors.
- Develop compact narrow-linewidth, tunable 780 nm laser sources with large modulation bandwidth via monolithic solid-state microchip design.
- Explore novel atom interferometer component designs, including BEC waveguides, guided atom beamsplitters.
- Demonstrate motion-compensated gravity gradiometer.

	FY 2003	FY 2004	FY 2005
Navigation Via Signals of Opportunity	0.000	0.000	5.000

(U) The Navigation via Signals of Opportunity (NAVSOPP) program will provide the U.S. Warfighter with the ability to navigate effectively when the Global Positioning System (GPS) is unavailable due to jamming or other effects. An outgrowth of the GPX program, the NAVSOPP program will develop the procedures and technologies for geolocation of stationary and mobile platforms via exploitation signals of opportunity or specialized signals from satellite, airborne, and terrestrial assets. The NAVSOPP is a two part program: (1) Cataloging and assessment of potential exploitable signals followed by analysis and performance modeling and hardware-based concept validation (2) Design and test of a prototype receiver(s) and algorithms for geolocation using the signals of opportunity. This would include demonstration of a non-form/fit functional prototype system.

(U) Program Plans:

- Evaluate feasibility of candidate approaches using modeling, analysis, and simulation.
- Develop critical NAVSOPP technologies and conduct phenomenological measurements to validate the down-selected concepts.
- Design, fabricate and test functional prototype system.
- Field test and demonstrate the functional prototype in realistic environments.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-01

(U) **Other Program Funding Summary Cost:**

- Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-02

COST (In Millions)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Aerospace Surveillance Technology SGT-02	33.850	24.614	36.375	38.289	43.279	32.749	30.720

(U) Mission Description:

(U) This project funds sensor efforts that will improve the accuracy and timeliness of our surveillance and targeting systems for improved battlefield awareness, strike capability and battle damage assessment. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with the tactical information needed to succeed in future wars. This operational surveillance capability must continue to perform during enemy efforts to deny and deceive the sensor systems, and operate, at times, in a covert manner. This project will exploit recent advances in multispectral target phenomenology, signal processing, low-power high-performance computing, and low-cost microelectronics to develop advanced surveillance and targeting systems.

(U) Program Accomplishments/Planned Programs:

	FY 2003	FY 2004	FY 2005
Counter-Underground Facilities	14.110	14.614	18.000

(U) Underground Facilities (UGFs) are being increasingly employed to hide a variety of tactical and strategic functions, including command and control, leadership escapes and hides, missile and artillery protection, and activities associated manufacture and storage of weapons of mass destruction. The Counter-Underground Facilities (CUGF) program is developing technologies to both find and characterize UGFs: identification of facility function, pace of activity, pre-attack status of the facility, trans-attack activities and post-attack status. Techniques are being developed to determine locations of critical systems (power, water, airflow and exhaust vents), orientation and depth of structure, and pre-strike and post-strike changes in the substructure resulting from attack. This program began by developing validated, phenomenological models for a range of UGF signatures: acoustic, seismic, electromagnetic (EM), chemical, multi/hyperspectral, and gravity/gravity gradient. These models enable the evaluation of multiple sensor/targeting concepts, and drive requirements for highly sensitive, advanced sensors. One concept under development, the Deployable Unattended Ground Sensor System (DUGSS), will demonstrate the use of multiple, networked ground nodes of multi-phenomenological sensors (EM, acoustic, seismic) for UGF monitoring and target characterization. Another element, Effluents for Vent Hunting,

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-02

has evaluated the feasibility of finding vents from stand-off locations by exploiting the spatial, spectral, and temporal characteristics of the exhaust plumes. Another concept, Low-Altitude Airborne Sensor System (LAASS), will demonstrate the use of airborne EM, acoustic, and gravity sensors to rapidly find UGFs and map out their backbone structure. To support the demonstrations of these concepts, the CUGF program is also developing or modifying E-field, B-field, acoustic, and gravity-based sensors and enhancing navigation communications and signal-processing techniques as necessary to meet the data-localization and data-exfiltration requirements.

(U) Program Plans:

- Completed signature data collection and characterization of geophysical site properties of UGFs.
- Completed model validation for seismic, acoustic, electromagnetic and effluent signatures and backgrounds and for effluent modeling tools.
- Evaluated concepts for effluent-based vent hunting and cave exploration, and developed candidate sensor designs for effluent-based characterization.
- Demonstrate functional prototype of multi-mode/multi-node ground sensor system, using clutter-limited sensors.
- Demonstrate rapid, airborne surveillance and mapping of UGF structures.
- Develop component technologies for deployable systems, including low-mass coupling of seismic vibration sensors, site-adaptive non-line of sight communications, and improved deployable EM and gravity sensors.
- Develop multi-sensor characterization tool for planning and targeting.

	FY 2003	FY 2004	FY 2005
Digital Radio Frequency Tags (DRAFT)	10.000	8.000	3.375

(U) The Digital Radio Frequency Tags program will develop a flexible, potentially low cost technology to allow radars (Moving Target Indicator (MTI) and Synthetic Aperture Radar (SAR)) to receive data from ground devices. This program will develop a small, lightweight and affordable RF Tag for data exfiltration from unattended ground sensors and for communication with vehicles and personnel throughout the battlespace. This is particularly useful for the identification and location of coalition units. Other advanced tag capabilities will be investigated and developed, adding additional communications capabilities to the tags for enhanced interoperability with combat identification and communications systems. These added capabilities will give the tags dual-mode capability: to function as a tag when radar is present, or to

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-02

function as a more conventional radio beacon device when radar is not available. Additionally, small-scale tag variations will be considered for other missions, including dismount and non-cooperative red-target tracking, with the net effect of substantially enhancing situational awareness and combat identification advantages for U.S. forces in conventional and unconventional ground operations.

(U) Program Plans:
- Complete 5 baseline radar tag prototype units.
- Complete design of advanced tag concepts.
- Conduct laboratory device testing and characterization.
- Conduct airborne field tests and user demonstration.
- Complete dual-mode tag communicator design.
- Demonstrate dual-mode tag communicating on SATCOM waveform.
- Develop dismount/red tag prototypes and conduct laboratory device testing and characterization.

	FY 2003	FY 2004	FY 2005
Rescue Transponder	0.000	2.000	6.000

(U) Building upon technologies developed in other sensor programs, the Rescue Transponder (RT) program will investigate the use of covert localization and tracking technology to provide a very low probability of detection (LPD) call for help signal. The system is expected to use a wide band radio frequency signal with low power and extremely low duty cycle. The goals of the RT Program are to develop a small, wearable, rugged, individual-worn transponder that provides a call for help to friendly forces that has a signal with substantial LPD margin, so that enemies are not able to exploit the signal to capture or detain friendly forces isolated on the battlefield or in a perilous location. The RT system will operate over ranges that enable rescue forces or surveillance systems to receive its signals while avoiding hostile fire or detection. It will support accurate localization by rescue forces, and permit transmission of identifying, authenticating, and status information.

(U) Program Plans
- Develop small wearable tags which enable the user to be identified and localized by airborne or advantaged receivers with a very LPD signal of the wearer's identity, location and status.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-02

- Design a custom digital and microwave integrated circuit to allow miniaturization.
- Build and test prototype tags, devices and transmitters and author viable manufacturing plans.
- Demonstrate the military utility of RT to transition partners.

	FY 2003	FY 2004	FY 2005
Threat Characterization of Buildings	0.000	0.000	5.000

(U) This program will develop technologies and systems for new surveillance capabilities of buildings. It will develop and demonstrate wall-penetrating multi-static Doppler radar for stand-off mapping of building layout (via long-term integration of human motion) and for localization of enemy forces immediately upon entering buildings (via portable radar "flashlights"). It will also demonstrate technologies to monitor the integrity of building envelopes, to identify a breach of previously sealed/secured buildings and to identify previously hidden connections between buildings; approaches include pressure and power-line monitoring as well as the use of tracer gases.

(U) Program Plans:
- Evaluate candidate designs for wall-penetrating Doppler radar.
- Evaluate candidate technical approaches for monitoring building envelope integrity.
- Prove feasibility in lab on sub-scale models.
- Design, build, and test prototypes for use in full-scale demonstration.

	FY 2003	FY 2004	FY 2005
Surveillance and Threat Neutralization in Urban Environments	0.000	0.000	4.000

(U) This program will develop systems to demonstrate the detection and defeat of threats specific to conflict and stabilization operations in the urban environment. These threats include roadside bombs, car bombs, suicide bombers, snipers, Rocket Propelled Grenades and mortars launched from inside urban boundaries. Detection technologies under development include intercept and localization of unintentional radiated emissions of

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-02

remote-control circuits; multi-static radars for standoff identifications of shrapnel-packed bombs; detection of anomalies in gait, heartbeat, and breathing; standoff identification and localization of explosive vapors/effluents; and multi-mode integrated acoustic- and radar-based systems to backtrack to the source of fire. Neutralization technologies include targeted RF jamming of triggers; techniques to cause incomplete detonation of explosives; portable fast-erecting blast shields; and technologies to non-destructively and reversibly control urban access routes.

(U) Program Plans:
- Evaluate candidate technologies for wide-area/standoff and choke-point/portal-screening applications.
- Prove feasibility in lab on sub-scale tests.
- Design, build, and test prototype for choke-point applications.
- Design, build, and test prototype for wide-area applications.

	FY 2003	FY 2004	FY 2005
Large Millimeter Telescope	9.740	0.000	0.000

(U) The Large Millimeter Wave Telescope (LMT) program was the U.S.-complement to a coordinated U.S.-Mexico project. The DARPA program provided technology assessments for design, systems integration and technology-leading metrology for a 50-meter aperture, fully steerable millimeter wave radio telescope. The fully developed telescope features a sophisticated laser metrology system to maintain precise alignment of the optics, and real-time closed loop adaptive control to maintain a near-perfect parabolic surface at all pointing angles and under most environmental conditions.

(U) Program Accomplishments:
- Continued fabrication of metrology panel and surface.
- Continued development of antenna holography system and precision pointing.
- Initiated system integration for construction of base line telescope.
- Integrated the antenna panels and metrology system into the telescope.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-02

(U) Other Program Funding Summary Cost:

- Not Applicable.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-03

COST (In Millions)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Air Defense Initiative SGT-03	18.413	31.434	32.861	27.398	29.314	34.167	34.133

(U) **Mission Description:**

(U) This project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats. These technology developments are embodied in the following programs: Low-Cost Cruise Missile Defense (LCCMD); Affordable Large Array (ALA); Global Eye; RF MEMS Improvement; and Integrated Sensor Is Structure (ISIS).

(U) **Program Accomplishments/Planned Programs:**

	FY 2003	FY 2004	FY 2005
Low-Cost Cruise Missile Defense (LCCMD)	8.265	12.129	10.000

(U) The LCCMD program will design, develop, demonstrate and transition an affordable electronically scanned array (ESA) seeker for use on a missile interceptor system to defeat unsophisticated air vehicles. Unsophisticated air vehicles are affordable, can be procured in large numbers to overwhelm U.S. defenses and provide a credible long-term threat to both civilian population centers and military targets. To reduce the cost of defending against such threats, it is crucial to reduce the cost of the guidance and control sections of defensive weapons. The LCCMD program will enable this through analyses, laboratory testing and field-testing of an all-weather seeker costing less than fifty thousand dollars in production. The program has pursued six novel concepts and is presently focused on the maturation and demonstration of radar seeker solutions employing active ESA concepts using low cost single-chip transmit/receive modules. In addition, the program is developing low-cost surveillance systems to provide the warning/cue for such interceptors.

(U) Program Plans:
- Build and test active ESA antenna.
- Fabricate seeker back-end and integrate with ESA seeker antenna in preparation for ground or flight test.
- Conduct ground or flight test (in collaboration with service transition partner).

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-03

- Initiate systems design for low-cost surveillance approaches to provide cue for low-cost interceptors.
- Conduct field measurements to support performance characterization of surveillance systems.
- Design and build prototype surveillance system for a small-scale feasibility demonstration.

	FY 2003	FY 2004	FY 2005
Affordable Large Array (ALA)	4.583	2.000	0.000

(U) The Affordable Large Array (ALA) program has developed ultra-low cost, lightweight, and low-power density X-Band transceivers and related technologies for potential use in conjunction with very large but foldable and easily transportable antenna apertures. The overall objective of the program was to develop and demonstrate these transceivers for population of very large, lightweight, active electronically scanned radars that could meet the future DoD needs of a wide variety of radar systems. Low-power, high efficiency, lightweight transceiver module technologies offer the important benefits of being able to operate reliably without the need for liquid or forced air cooling The technical challenges addressed under this program include the development of single chip transmit/receive modules with very low overhead power, (efficient and lightweight), techniques for distributing wideband RF, control signals, and DC power throughout the large arrays, and methods for dynamically calibrating these large flexible arrays. Other potential applications of ALA technologies include easily transportable, less expensive Ground Based Radar systems and aerostat-based systems for observing very low flying targets. It may also be possible to replace hard-wired beam steering control and RF manifolds by optical and RF space-fed configurations, which will result in additional significant savings in cost and weight.

(U) Program Plans:

- Conducted studies and experiments to develop alternative array feed technologies that are applicable to very large arrays.
- Conducted power-aperture trade studies to determine the appropriateness of these technologies for applications including ground-based radars, radars for mid-course cruise missile defense and airborne low-power-density, large-scale radars.
- Completed testing of prototype transmit/receive (T/R) cells fabricated in SiGe, InP, and GaAs.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-03

	FY 2003	FY 2004	FY 2005
Integrated Sensor Is Structure (ISIS)	0.000	8.800	14.000

(U) The ISIS program (previously called "Lightfoot Radar") will develop antenna technologies that transform the transportability of sensor and communications systems. Program goals are the reduction in total system weight, prime power consumption, fuel requirements, and personnel requirements, so as to enable an unmanned airborne surveillance and communication system that provides persistent monitoring of all airborne and ground-based battlefield targets and simultaneously meets battlefield comms needs, over one full year of continuous operation. It is anticipated that the unprecedented power-aperture necessary to meet the program goals can only be provided by fully integrating the sensor into a station-keeping airship platform – hence, the name ISIS: "Integrated Sensor Is the Structure".

(U) Program Plans:

- Develop large-scale signal distribution and single chip electronics technologies to enable extremely large low-power active array antennas.
- Develop lightweight tensional structures and dynamic calibration techniques to enable semi-flexible active array antennas.
- Develop terahertz sources and signal processing techniques to enable hand-held sensors.
- Develop discrete switches or bi-state materials to enable steerable reflect arrays.
- Develop passive RF tags or nano-particles to be remotely queried by ISIS.
- Develop conceptual designs that meet ISIS program goals.
- Develop and test required technologies, including large-scale signal distribution, low-power-density single-chip electronics, light-weight tensional structures, dynamic calibration techniques.
- Build and demonstrate a prototype ISIS system or sub-system.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-03

	FY 2003	FY 2004	FY 2005
RF MEMS Improvement	4.682	8.505	8.861

(U) RF MEMS switches in the X, Ka, and Ku band hold great promise for DoD radar applications due to their inherent small size, light weight, low power consumption and low loss. The RF MEMS Improvement program will extend lifetimes, develop inexpensive packaging techniques, and enhance RF performance of RF MEMS switches to allow use in devices such as phase shifters, reconfigurable apertures, and tunable filters.

(U) Program Plans:
- Develop process improvements, supported by predictive performance models, in competing MEMS fabrication and packaging techniques.
- Perform six design and testing iterations of packaged MEMS.
- Demonstrate ability to fabricate low-cost, low-loss, long life MEMS switches meeting DoD requirements.

	FY 2003	FY 2004	FY 2005
Global Eye	0.883	0.000	0.000

(U) The Global Eye program developed lightweight low-cost electronically scanned array (ESA) technology capable of supporting multiple simultaneous radar modes and frequencies through the use of mono-static or pseudo-mono-static apertures operating in a simultaneous transmit and receive (STAR) mode. Platforms outfitted with this capability provide lower cost continuous air and ground surveillance of low intensity areas such as no-fly zones and peacekeeping areas. Such capability could supplement traditional AWACS and JSTARS and potentially reduce the requirement to forward base large numbers of such aircraft for these purposes. The key technologies developed included an X-band proof-of-concept ESA risk reduction array capable of supporting up to a 100% transmit duty factor using currently available transmit/receive (T/R) modules, beam polarization diversity, and advanced mode control/interleaving algorithms.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-03

(U) Program Plans:
- Completed the building and testing of demo array.
- Demonstrated pseudo-mono-static ESA operation using a 1 sq ft risk reduction array and a separate X-band receive aperture.
- Evaluated its ability to support multiple-mode, multiple-frequency, and radar operation during ground testing with a Moving Target Simulator (MTS) and a mechanically scanned receive aperture.

(U) **Other Program Funding Summary Cost:**

- Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

COST (In Millions)	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009
Sensors and Exploitation Systems, SGT-04	123.276	127.483	130.637	120.867	117.545	128.610	158.463

(U) **Mission Description:**

(U) The Sensors and Exploitation Systems project develops and demonstrates advanced sensors, and exploitation technologies. These efforts, along with those in Projects SGT-01, SGT-02 and SGT-03, provide warriors with situational awareness and precision target identification. The project is driven by four needs: (1) countering camouflage, concealment and deception (CC&D) of mobile ground targets; (2) providing near-real-time, semi-automatic exploitation of wide-area moderate- and high- resolution imagery; (3) obtaining real-time, accurate battle damage assessment; and (4) accomplishing robust, precise identification, precision fire control tracking and engagement of high value targets. These needs are addressed by the following programs: Advanced Exploitation Systems Technology, Network Centric Sensing and Engagement, Advanced Optical Sensor Technology, and Advanced Radar Sensor Technology.

(U) **Program Accomplishments/Planned Programs:**

	FY 2003	FY 2004	FY 2005
Advanced Exploitation Systems Technology	32.500	47.004	47.998

(U) The Advanced Exploitation Systems Technology program develops systematic means to interpret and exploit sensor data, semi-autonomously. The objective is to detect and identify military threats. Data sources include national, theater and, organic surveillance and reconnaissance systems. Critical performance issues are timeliness, accuracy, error rates, and interpretation workload. The program addresses the challenges of target acquisition and tracking under restrictive rules of engagement. It applies advanced signal processing and machine vision to leverage advances in sensor capabilities. Initiatives in this program include the following:

- Frequency-Diverse Spatial/Spectral Sensor Exploitation develops methods to better utilize advanced sensors. The initiative encompasses high-resolution multispectral, multipolarization, radio frequency, electro-optical (EO) and active optical sensors. The program

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

significantly improves mapping, terrain characterization, target detection and situational awareness. It explores applications for both medium- and high-altitude deployment. This technology permits fusion, automated exploitation and visualization of products from diverse classes of sensors. These sensors and processing techniques enable commanders to enjoy wide-area detection, characterization and geolocation information. They apply to facilities, vehicle and dismounted targets in both tactical situation awareness and strategic indication and warning. These tools support rapid mapping and terrain characterization support in near-real time to support robotic and manned maneuver forces.

- The National/Tactical Exploitation (NTEX) initiative develops technologies to locate and identify enemy air defense units. It uses multi-source imagery and data from both National reconnaissance systems and tactical sensor assets. Under a DARPA Memorandum of Agreement with the National Imagery and Mapping Agency (NIMA), the project places researchers in facilities with access to real data and analysts managed by the "Geospatial Intelligence Advancement Testbed" project at NIMA. They submit their sensor exploitation developments for rapid assessment by operational analysts using real world data. NTEX builds upon technologies developed under the DARPA Semi-Automated IMINT Processor Advanced Concept Technology Demonstration. It demonstrates increased capability to model, detect, and locate air defense targets and surface threats, including those that have been denied, modified or have not yet been modeled.

- Video Verification and Identification (VIVID) (formerly Video Exploitation Technology (VET)) develops technology to automate airborne video exploitation. Program products support precision strike operations and urban surveillance. VIVID enables the handoff of targets between wide area coverage Intelligence, Surveillance, and Reconnaissance systems and local video surveillance platforms. It investigates techniques for precision target identification in video. These include fingerprinting techniques and related technology to permit reacquiring previously-seen vehicles. The program also features techniques enabling video sensors to autonomously track people and multiple vehicular targets through dense traffic in military areas of operation overseas. It supports target area searches for non-combatants and "no-strike" entities, to mitigate collateral damage. VIVID technologies significantly advance the capabilities of video surveillance for a number of military missions, including counter-terrorism and military operations in foreign urban areas.

- Tactical Sensor Network Technologies (TSNT) develops detection, tracking, identification, and pattern analysis capabilities that operate in all nodes (fixed or mobile) within a networked, distributed multi-sensor system. The processing to be performed at each network node depends on the sensors reporting to that node, the subscribing commanders, and resource management decisions. TSNT exploits locality of sensing, but will leverage the advantages of a self-forming adaptive network for signal processing. Algorithms are designed to be

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

aware of the sensor network and adapt their processing algorithms based on self-discovered network topology. The algorithms also take into account power management constraints, communications bandwidth limitations and constraints found in the local environment. TSNT is resilient to the failure of any node while maintaining sufficient consistency to support commanders' collaborative tactical planning.

- The Exploitation of 3-D Data initiative (E3D) develops techniques for rapidly exploiting 3-D sensor data. Such data is proliferating from growing numbers of advanced sensors such as Ladar and IFSAR. The data represent a rich resource for use in precision target identification. E3D demonstrates that the target identification value of 3-D information greatly surpasses that of 2-D image-based methods. Program effort consists of three modules. The Target Recognition module investigates the object recognition process. The Target Acquisition module develops target acquisition methods based on search of a local 3-D volume for possible targets. The Modeling module enhances identification methods based on detailed shape analysis. The resulting software tools are designed to be integrated into a number of ground stations to receive 3-D sensor data.

- The Dynamic Tactical Targeting (DTT) initiative is developing sensor control and data fusion technologies to enable a tactically responsive warfighter-managed targeting process. Recent events reinforce the need for warfighter-managed technologies that find, identify, track, target and destroy mobile, time sensitive targets (TSTs). Current targeting technology is too slow to maintain target track and support prosecution of these fleeting targets. DTT is designing and demonstrating a system that: (a) leverages existing National/Theater intelligence, surveillance and reconnaissance (ISR) processes for timely extraction of critical data; (b) fuses organic sensor data with ISR data from all sources to enable multi-scale estimation of target location, identity and activity; (c) dynamically tasks standoff, organic, and embedded sensors to fill ISR coverage gaps and provide relevant sensor observation in areas of tactical interest; and (d) processes and manages the large volume of data produced by all these sensors in time to give shooters the information required to prosecute TSTs.

(U) Program Plans:

- Frequency-Diverse Spatial/Spectral Sensor Exploitation.
  - -- Design, analyze and assess new concepts for exploitation of advanced sensors: RF, EO/IR and active optical frequency-agile spatial/spectral/polarimetric.
  - -- Perform phenomenological investigations to assess target signature stability, variability and separability. Develop prototype tools for exploiting these signatures.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

-- Design, develop and evaluate brassboard sensor hardware and evaluate system performance under controlled environments.
-- Design, develop and evaluate form, fit and function sensor hardware.
-- Integrate on aircraft and evaluate performance in flight test over realistic targets and large clutter sets.

– National/Tactical Exploitation.
-- Demonstrate the ability to recognize components of specific air defense units using automated processing of national/tactical sensor data.
-- Demonstrate the ability to model targets observed from a few sensor views, then locate and recognize those targets autonomously in subsequent imagery.
-- Demonstrate the ability to model denied and expedient targets from a few sensor views, then locate instances of those targets that would otherwise be missed by analysts, in a real-world practical problem.

– Video Verification of Identity.
-- Develop techniques to automate detection, classification, and tracking of enemy, mobile, surface targets in visible and infrared motion imagery acquired by unmanned air vehicles.
-- Develop automated techniques to detect moving vehicles and people that could become unintended casualties in the vicinity of an impending weapon strike.
-- Demonstrate integrated, semi-automated engagement of hostile surface targets with precision weapons guided by data from video sensors on airborne platforms.

– Tactical Sensor Network Technologies.
-- Develop algorithms for distributed situation assessment at all nodes of a networked group of sensors.
-- Integrate and assess distributed system performance in large-scale simulation and limited-scale testing.
-- Demonstrate robustness of TSNT networked sensing under network and environmental stresses.
-- Incorporate tracking, target identification, and target assignment algorithms for fully distributed operation.

– Exploitation of 3-D Data.
-- Provide additional synthetic data and collected advanced laser radar (LADAR) data for research and development modules.
-- Acquire and refine 3-D models of potential target vehicles.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

-- Develop tools to locate, classify, identify, and characterize the operational states of ground targets using data from 3-D sensors (e.g., LADAR) making use of structural models of candidate target geometries.
-- Proliferate structural models to encompass hundreds of candidate target types
-- Expand capabilities to perform precision recognition in the presence of articulation and obscuration.
-- Improve performance of real time processing.
-- Extend model-based vision technologies to classify, identify, and characterize the operational state of ground targets from other sources of 3-D sensor data.

– Dynamic Tactical Targeting.
-- Demonstrate human interaction with closed-loop control of fusion and sensor management in a simulation environment.
-- Develop 4D registration of multiple tracks that is fast enough to enable continuous tracking of multiple targets.
-- Develop information fusion methods and the capability to plan and re-plan appropriate sensor platforms. Enable continuous track of multiple time-sensitive targets simultaneously.
-- Develop end-to-end robust system capability with integrated DTT components in the Air Force Research Laboratory testbed.
-- Develop system measures of performance for evaluations.
-- Integrate the system with an existing Air/Ground Battlespace Simulator/Testbed and perform experiments.
-- Complete a robust laboratory demonstration of the system.
-- Build a system for use in field demonstrations.

	FY 2003	FY 2004	FY 2005
Network Centric Sensing and Engagement	39.542	29.891	24.100

(U) The Network Centric Sensing and Engagement Program develops technology and tools to support precise situational awareness, rapid targeting, and precision engagement through the exploitation of systems of networked sensors. Network-centric sensing treats a group of sensors as a system. It leverages networked intercommunication to enable system performance much superior to that of uncoordinated individual sensors. Applications include advanced target detection, acquisition, tracking, and combat identification. The technology is suited to ground based fixed and mobile sensors and airborne multi-ship sensor systems. Exploiting the potential of network-centric sensing requires a number of approaches.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

Required technology advances include: sensor-to-sensor communications; multi-sensor management; sensor system georegistration; real-time data fusion; advanced tracking; and network-centric sensor operational modes. Initiatives in this program include the following:

- The Camouflaged Long Endurance Nano-Sensors (CLENS) (formerly Micro-Sensor Fields) initiative develops low-cost, lightweight micro-sensors for area reconnaissance and perimeter monitoring. It will support warfighter operations in complex and urban terrain. Its sensors operate in both monostatic and bistatic modes. The program emphasizes low-power and long-life detection and discrimination capabilities. Enabling technologies include ultra-wide band radar, advanced sensor power management and generation, and low-power computing. The effort is developing robust techniques for rapid geolocation and data exfiltration from sensors. It demonstrates technology for visualizing networks and fields of micro sensors and exploiting and fusing data received from them. CLENS enables force protection with greatly reduced manning. It supports monitoring of borders and critical CONUS sites, long-duration covert monitoring of target sites such as terrorist camps, and deep-strike engagement of mobile targets. It has broad application in support of comprehensive intelligence, surveillance, and reconnaissance for situational awareness. CLENS enables persistent sensing of dismounted combatants in the toughest of environments, such as forested areas.

- The Tactical Targeting Network Technologies (TTNT) initiative develops rapidly reconfigurable, affordable, robust, interoperable and evolvable communications technologies. Resulting technologies support airborne network-centric targeting. Goals for the TTNT tactical network are: (1) reconfigurable in fractions of a second; (2) wideband capacity (10+Mbit/s) on demand; (3) near zero (2ms) latency for high priority messages; (4) complete interoperable with Link 16; and (5) inexpensive to procure and to install. This program addresses technical issues including physical waveforms and frequency allocations, fast security subsystems, and distributed network management. It is developing novel digital processing techniques to eliminate the need for centralized network synchronization. TTNT is pursuing an omni-antenna-based approach with a self-adaptive, channel-sensing, multiple user access protocol. It employs spread spectrum waveforms optimized for rapid carrier acquisition, featuring powerful turbo code error detection and correction. This physical layer provides well-integrated security architecture. The network architecture is designed to exploit commercial-off-the-shelf technology wherever possible. TTNT will incorporate Joint Tactical Radio System software defined radio standards. Performance in simulations and laboratory testing with bread-board equipment exceeds the current phase program goals. TTNT is designing and fabricating a full security architecture brass-board system. The program separately developed a novel Ku band directional antenna. The antenna promises 20+Mbit/s connectivity between intelligence, surveillance and reconnaissance assets, tactical aircraft, and small unmanned air vehicles using the Common Data Link family of radios.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

- The Affordable Moving Surface Target Engagement (AMSTE) initiative develops technologies required to network existing radar sensors. Of particular interest are tactical and theater ground moving target indication (GMTI) sensors. The program enables affordable, all-weather, precision negation of moving surface targets (both land- and sea-based), from stand-off ranges. Precise cueing from netted GMTI sensors will reduce the complexity and thus the cost of precision munitions. AMSTE demonstrates in-flight midcourse and terminal guidance to weapons resulting in accuracy an order of magnitude better than current systems against moving targets. The program also demonstrates unaided precision grid locking techniques and low-cost weapon data links. AMSTE advanced multi-platform tracking algorithms deliver precise and long-duration, high-confidence track purity using moving target feature phenomenology for track maintenance.

- The Rotorcraft SIGINT/COMINT Geolocation initiative develops network-based signal geolocation technology for rotorcraft application. The program enables collaborative interaction between multiple rotorcrafts (manned or unmanned) for mapping, location and engagement of RF emitters. This effort develops techniques to mitigate rotor blade induced multipath. It demonstrates appropriate receiver, signal processing and antenna technology, enabling ad-hoc rotorcraft networks to rapidly characterize emitters.

(U) Program Plans:

– Camouflaged Long Endurance Nano-Sensors.
  -- Develop breadboard ultra-wide band radar micro-sensor for dismount detection and tracking.
  -- Design receiver node to process micro-sensor detects into tracks and exfiltrate data.
  -- Develop tracking algorithms to consolidate range-only detects into contact tracks.
  -- Fabricate targeted form factor micro-sensors.
  -- Conduct ground demo with one receiver/processor and many micro-sensors.

– Tactical Targeting Network Technologies.
  -- Complete brass-board design and fabrication.
  -- Complete brass-board TTNT flight experiments and demonstrations at large scale.

– Affordable Moving Surface Target Engagement.
  -- Complete development and fabrication of the final field experiment system for demonstration in an integrated operational environment.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

-- Demonstrate a full AMSTE weapons delivery capability with advanced target track maintenance in live weapons drops with moving targets.

– Rotorcraft SIGINT/COMINT Geolocation.
-- Analyze interactions between threat signals and rotor blades.
-- Validate analyses with tower tests.
-- Build a prototype airborne system.
-- Validate single-ship performance with flight tests.
-- Interface prototypes to the inter-ship communications net.
-- Demonstrate multi-ship operation in flight tests.

	FY 2003	FY 2004	FY 2005
Advanced Optical Sensor Technology	18.992	21.464	26.519

(U) The Advanced Optical Sensor Technology Program develops technology to significantly improve warfighter situation awareness, surveillance, reconnaissance and targeting. The program exploits advancements in electro-optic, hyper spectral imaging, optical polarimetry and advanced three dimensional active optic sensing. Initiatives in this program include the following:

- Standoff Precision ID in 3-D (SPI 3-D) develops an affordable sensor package capable of high-resolution 3-D images for confirmatory ID at long ranges. The sensor overcomes weapons-effects obscuration, and penetrates foliage, camouflage and cloud layers. The system provides intensity, range and polarization for each pixel in the field of view. The program conducts a series of ground, air and unmanned air vehicle demonstrations of standoff 3-D Ladder precision ID and track fusion techniques. The objectives are to provide: (1) rapid acquisition; (2) polarization exploitation; (3) intensity mapping; and (4) high range resolution. The results provide commanders with significantly improved identification of enemy ground moving targets. Demonstrations employ existing commercial-off-the-shelf optics, focal plane arrays and gimbals, combined with a novel polarization-to-range mapping technique.

- The Synthetic Aperture Ladar for Tactical Imaging (SALTI) initiative will develop and demonstrate an airborne interferometric synthetic advanced laser radar (LADAR) imager capable of producing high-resolution three-dimensional imagery at long ranges. The system will

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

combine the long-range day/night access afforded by conventional synthetic aperture radar (SAR) with the interpretability of high-resolution optical imagery and the exploitability of three-dimensional (3-D) imagery. These capabilities will be provided within a tactical-sized package suitable for deployment on a long-range unmanned air vehicle such as the Global Hawk. The technical objective of the program is to provide a proof-of-concept for operation at tactically relevant high altitudes and at long ground ranges. A secondary goal of the program is to demonstrate single-view ground moving target indication (GMTI) with targeting quality absolute accuracy in range and cross-range when operating in a coherent, real-aperture mode.

- Eyeball is developing novel methods for precision target identification (ID) of moving and stationary tactical targets from standoff platforms. It employs electro-optical sensors working in conjunction with air and space-based radar Ground Moving Target Indication (GMTI) and Synthetic Aperture Radar (SAR) sensors. Future radar assets are expected to be capable of performing target detection, location and tracking, and even some forms of target classification. However, GMTI-SAR target ID performance is expected to remain constrained by radar and signature limitations. The Eyeball sensor will exploit the benefits of combining spatial, spectral and polarimetric signatures from sparse or filled apertures to enable real-time precision ID of critical tactical targets. In the concept of operations, a GMTI-SAR platform will hand-off moving and stationary target location information to the Eyeball sensor. Eyeball will identify the target at standoff range and return the target ID to the radar for track-file association. Through episodic revisits, Eyeball will enable the GMTI-SAR platform to maintain continuous track of the tactical target. The program will deliver the necessary understanding of what is required in terms of combined spatial, spectral, and polarimetric signatures and resolution trades across the sensing domains to realize target-quality ID performance.

- The Fogcutter initiative explores novel methods for optical imaging in the presence of fog, clouds, and other aerosols. The objective is Visual Flight Rules (VFR)-like performance for air vehicles in Instrument Flight Rules (IFR) conditions. Initial technology demonstrations will take place in a maritime environment.

(U) Program Plans:

– Standoff Precision ID in 3-D.
  -- Develop and test brassboard of complete imaging system, including laser and Pockels' cell elements.
  -- Determine accuracy and precision of ranging technique.
  -- Develop flight engineered system.
  -- Perform full-up ground tests from mountaintop test range.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

-- Integrate and demonstrate system from manned aircraft against moving targets.
-- Integrate system into air vehicle and fully demonstrate against a variety of ground targets.

– Synthetic Aperture Ladar for Tactical Imaging.
-- Develop a laser transmitter containing an extremely stable local optical oscillator and other oscillators, modulators and power amplifiers necessary to create the time-dependent waveform and power required for synthetic aperture imaging.
-- Develop a multi-element detector array including analog and digital electronics for coherently reading all elements of the array.
-- Integrate the detector array with an optical master oscillator to form a coherent receiver.
-- Develop image formation processing algorithms to coherently combine multiple laser pulse returns and to compensate for platform motion during the collection of these multiple pulses.
-- Demonstrate the collection of optical synthetic aperture imagery from an airborne platform and that produces high-resolution 2D and 3D image products.

– Eyeball
-- Conduct additional ground-based experiments at North Oscura Peak to complete the data collection.
-- Design an airborne sensor system and evaluate utility and concepts of operation.

– Fogcutter
-- Develop imaging technologies to detect optical signals in strong scattering and absorptive environments, such as clouds.
-- Develop techniques and technologies for false alarm and clutter mitigation.
-- Collect data for characterization of targets operating in obscured settings.
-- Conduct and evaluate phenomenology, modeling and architecture/systems trades.

	FY 2003	FY 2004	FY 2005
Advanced Radar Sensor Technology	32.242	29.124	32.020

(U) The Advanced Radar Sensor Technology program promises significant improvements in military sensor performance in situation awareness, surveillance, reconnaissance and targeting applications. Its emphasis is on surface targets and threats. Program efforts are focused on

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

exploiting emergent and novel radar sensing technology and phenomenology. Key elements are advancements in ultra-wide band, biostatics, UHF/VHF, polarimetric change detection, tomographic imaging, space-time adaptive processing and other advanced signal processing, advanced Ground Moving Target Indication (GMTI) techniques, and foliage and ground-penetrating radar phenomenology. Program developments are integrated with current and emerging military platforms. Emphasis is on the most stressing military radar sensor challenges. Examples are operations featuring complex cluttered ground environments; those against small and slow moving surface targets; and situations where camouflage, decoys and countermeasures must be overcome. Initiatives in this program include the following:

- The Wide Area All Terrain Change Indication Technologies (WATCH-IT) initiative is developing real-time VHF/UHF synthetic aperture radar (SAR) automatic change detection and discrimination technologies. These provide the commander with rapid, robust detection of threat systems in the open, under camouflage and in foliage. WATCH-IT features discrimination algorithms to examine change detections, to determine if they have threat vehicle characteristics. Indications of change cue on- or off-board high-resolution sensors to perform target identification. WATCH-IT is designed to operate from platforms such as the high altitude unmanned air vehicle (UAV). It will demonstrate high area-coverage rates with few false alarms. It provides commanders with a critical capability that currently does not exist. The program also develops techniques to extract 3-D vehicle images from multiple-pass polarimetric SAR imagery. This enables rejection of confusers (i.e., decoys, relocated vehicles that are not of military significance), and thus greatly improves target classification/ identification.

- The Foliage Penetration (FOPEN) Reconnaissance, Surveillance, Tracking and Engagement Radar (FORESTER) initiative supports the Future Combat Systems (FCS) and the U.S. Army Objective Force. It is developing a Foliage Penetration **(**FOPEN) Ground Moving Target Indication (GMTI) radar. This radar promises persistent, long-term detection and tracking of enemy combat vehicles and dismounted troops moving in open and forested areas of the battlefield. The technology allows Objective Force commanders to operate with confidence in forested areas. It also detects low-flying aircraft such as helicopters and ultra-lights. Its synthetic aperture radar images support terrain delimitation, road identification, and target tracking in wooded areas. FORESTER is a UHF-band FOPEN GMTI radar for deployment on rotary wing platforms such as the A160 unmanned helicopter. The radar, operating from a hovering platform under calm wind conditions, can achieve calm-weather detection ranges in excess of 30 km against dismounted troops moving in forested areas. It employs adaptive antenna processing and innovative radar waveforms to overcome radio frequency interference and electronic countermeasures in hostile electromagnetic environments. In FY04 and beyond, this program will be funded in PE 0603764E, Project LNW-03.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

- The Knowledge Aided Sensor Signal Processing and Expert Reasoning (KASSPER) initiative radically alters the fundamental "front-end" signal processing architectures of advanced military sensors. It accomplishes this through the real-time integration of a dynamic environmental knowledge database. Real-time "environmental awareness," absent in conventional systems, dramatically improves clutter and interference rejection and significantly enhances sensor products. Current radio frequency sensors with adaptive signal processing estimate the background interference using sample statistical estimation. This necessarily entails an explicit assumption of stationarity. However, sensors operating in real environments around the world demonstrate that this homogeneity assumption is not valid. The problem manifests itself in increased false alarms, decreased target detections, and substantially degraded minimal detectable velocities in GMTI systems. KASSPER leverages the advent of detailed databases and high fidelity models to address inhomogeneities and non-stationarity at the front end of adaptive signal processing systems. Key technologies include advanced algorithms and high-performance computing architectures capable of memory-intensive adaptive signal processing. The program includes data collections, and a real-time demonstration of its processing gains.

- The Counter Camouflage, Concealment and Deception (Counter CC&D) program significantly enhances the commander's capability to detect and track targets hidden under foliage and camouflage. The program is validating Foliage Penetration (FOPEN) target detection and false alarm rejection capabilities. A FOPEN synthetic aperture radar (SAR), developed for demonstration on a manned RC-12 aircraft, provides inputs via tactical data links for ground image exploitation. A Ground Control and Display Subsystem provides real-time, remote operation of the FOPEN SAR, Automatic Target Detection and Cueing, and a Common Imagery Ground/Surface System-compliant exploitation interface. The program is developing advanced change detection and three-dimensional tomographic imaging algorithms. Program-developed techniques characterize terrain cover and the bald-earth topography in support of Future Combat Systems.

- The Generation After Next Airborne Surveillance Radar (GAN) initiative develops new concepts for wide area coverage airborne ground surveillance radar technology by exploiting wide beam staring systems rather than narrow beam scanning systems. This approach overcomes challenges associated with low revisit rates, limited concurrency of modes, low power efficiency, low resolution, and difficult sensor management problems. The program develops techniques to demonstrate critical concepts, including: (1) very high revisit rates; (2) high concurrency of modes (e.g., simultaneous SAR and GMTI, with potentially every pulse used for every function); (3) high power efficiency (again, every pulse used for every function); (4) high resolution (due to tomographic processing of wide angles); and (5) potentially straightforward sensor management (sensor management becomes a post-processing decision rather than a pre-sensing decision). GAN is demonstrating that these concepts, in turn, offer significant improvements in detection, tracking, and ID. By

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

supporting several modes on the aperture concurrently, GAN offers better than an order-of-magnitude improvement in radar productivity relative to current and emerging systems

- The Tethered Ultra-Long baseline Sparse Aperture (TULSA) initiative is developing new means of exploiting single-ship airborne long-baseline sparse apertures. This initiative develops techniques for deploying, calibrating, powering, feeding and processing received signals from active end bodies deployed on long, towed tethers. It also develops signal processing to support use of single-aircraft, towed long-baseline sparse arrays for (1) emitter geolocation, and (2) long baseline multi-static radar applications such as GMTI multi-lateration. TULSA promises high-confidence geolocation of emitters from a single aircraft. It provides commanders with characterization and targeting information for facilities, vehicles and dismounted targets. It also delivers tactical situation awareness, and supports strategic indication and warning.

(U) Program Plans:

– Wide Area All Terrain Change Indication Technologies.
  -- Collect data using low-frequency, high-resolution polarimetric SARs.
  -- Quantify the robustness of wide area change detection to factors such as aircraft heading, depression angle, database aging, topography and terrain cover. Exploit initial target and clutter data collected at Camp McCain, MS and Yuma, AZ.
  -- Assess alternative change detection algorithms to determine robustness to data variations, computational requirements, and other factors impacting suitability for implementing on a UAV.
  -- Quantify probability of detection and false alarm rate for a range of operating conditions.
  -- Investigate methods to generate synthetic target signatures using software models or scaled frequency measurements.
  -- Demonstrate WATCH-IT using the Foliage Penetration (FOPEN) SAR ATD system. Demonstrate real-time on-board change detection and high-speed discrimination processing in the ground station.
  -- Develop system specification for a fully integrated WATCH-IT system.
  -- Develop, integrate, install and flight test the WATCH-IT on a manned or unmanned aircraft.

– Foliage Penetration (FOPEN) Reconnaissance, Surveillance, Tracking and Engagement Radar.
  -- Demonstrate detection of slowly moving ground targets in foliage by rotorcraft-mounted GMTI radars through measurements, simulations and analyses.
  -- Design, assess, and evaluate a brassboard FORESTER hardware system.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

-- Design, assess, and evaluate a form-fit-and-function FORESTER hardware system for rotorcraft installation.
-- Conduct end-to-end system performance tests that include aircraft effects under static and dynamic conditions.
-- Conduct airborne flight-testing and demonstrate performance with the fully integrated FORESTER/aircraft system.

– Knowledge Aided Sensor Signal Processing and Expert Reasoning.
-- Develop advanced expert-reasoning algorithms using real and simulated data sets in non-real-time (offline) and real-time modes.
-- Develop real-time, high-dimensionality KASSPER software.
-- Conduct off-line KASSPER Constant False Alarm Rate & Radar (CFAR) demonstration.
-- Define high performance embedded computing architecture to enable rapid memory access; design, build, test, and demonstrate.
-- Demonstrate KASSPER performance gains in real-time processing environment using real data sets.

– Counter Camouflage, Concealment and Deception.
-- Collect and assess data to support terrain characterization under foliage.
-- Support the Air Force's Targets Under Trees (TUT) initiative.

– Generation After Next Airborne Surveillance Radar.
-- Develop the generation-after-next standoff airborne ISR radar.
-- Develop missions and concepts of operation to evaluate GAN sensor concepts against.
-- Outline basic functional requirements to support proposed missions and concepts of operation.
-- Develop strawman concepts for GAN and evaluate their ability to satisfy the specified functional requirements.
-- Establish basic technology requirements.
-- Develop a roadmap outlining an objective GAN system and an investment strategy.
-- Develop a GAN prototype system and demonstrate its effectiveness in appropriate field activities.

– Tethered Ultra-Long baseline Sparse Aperture.
-- Develop and demonstrate a multi-sensor localization concept.
-- Develop and evaluate relative navigation concepts to achieve desired geolocation accuracy.
-- Develop system and demonstrate system's capability against militarily significant targets.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2004
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Sensor and Guidance Technology PE 0603762E, Project SGT-04

(U) **Other Program Funding Summary Cost:**

- Not Applicable.

THIS PAGE INTENTIONALLY LEFT BLANK